# CHAPTER 2

## PRECOLLEGE EDUCATION

### Overview

Precollege participation in science and mathematics influences participation of women, minorities, and persons with disabilities in science and engineering. Current and historical differences in science and mathematics course taking and scores on achievement tests influence current and future participation by these groups in postsecondary science and engineering education and employment.

This chapter examines (1) factors influencing achievement, (2) precollege science and mathematics course taking, (3) mathematics and science achievement test scores, (4) high school completion rates, and (5) college entrance examinations.

### Influences on Mathematics and Science Achievement

Although gains have been made by women and minorities in mathematics and science achievement—as measured by elementary and secondary assessment test scores and by college entrance examinations—differences remain. These differences in achievement can then become a basis for unequal participation in further mathematics and science education, employment, and technological and science literacy. This section addresses factors that influence mathematics and science achievement—factors that account for both gains in achievement in some areas and persistent differences among groups in other areas. It should be noted that these factors influence the achievement of *all* students, regardless of sex, race/ethnicity, or disability status.

#### Mathematics and Science Course Taking

A primary factor contributing to mathematics and science achievement is mathematics and science course taking. Both the number and type of courses taken are positively related to achievement (Oakes, 1990; Peng, Wright, and Hill, 1995). One of the factors contributing to the increase in science and mathematics achievement test scores (as measured by the National Assessment of Educational Progress discussed on page 15) over time could be the increase in science and mathematics course taking (NSB, 1996). Differences in course taking by gender, race/ethnicity, and disability status, thus may contribute to differences among these groups in science and mathematics achievement.

#### Family Income and Education

Differences in mathematics and science achievement are also related to differences in family income and parents' education. Socioeconomic status (parental occupation, education, and income) accounts for a substantial amount of the differences in mathematics achievement (Ekstrom, Goertz, and Rock, 1988; Madigan, 1997). Students at grades 4, 8, and 12 whose parents had less than high school education scored lower in science and mathematics than students whose parents had higher levels of education. Similarly, those students eligible for the free or reduced price lunch program (an indicator of parental income) scored lower than those not eligible (Campbell et al., 1996). Poverty may explain some of the differences in females' and males' Scholastic Assessment Test (SAT) scores: a higher proportion of women than men SAT and American College Testing (ACT) test takers are from low-income families. Poverty may also explain some of the racial/ethnic differences in achievement test scores: blacks and Hispanics are more likely than whites and Asians to live in poverty. In 1995, poverty rates were 8.5 percent for non-Hispanic whites, 29.3 percent for blacks, 30.3 percent for Hispanics, and 14.6 percent for Asians (Baugher and Lamison-White, 1996). Further, children in poverty are more likely to have disabilities. Poverty is associated with health problems and learning disabilities: a higher proportion of children from low-income families than from higher income families are in special education because of developmental delays, learning disabilities, and emotional disturbances (U.S. Department of Education, 1997).

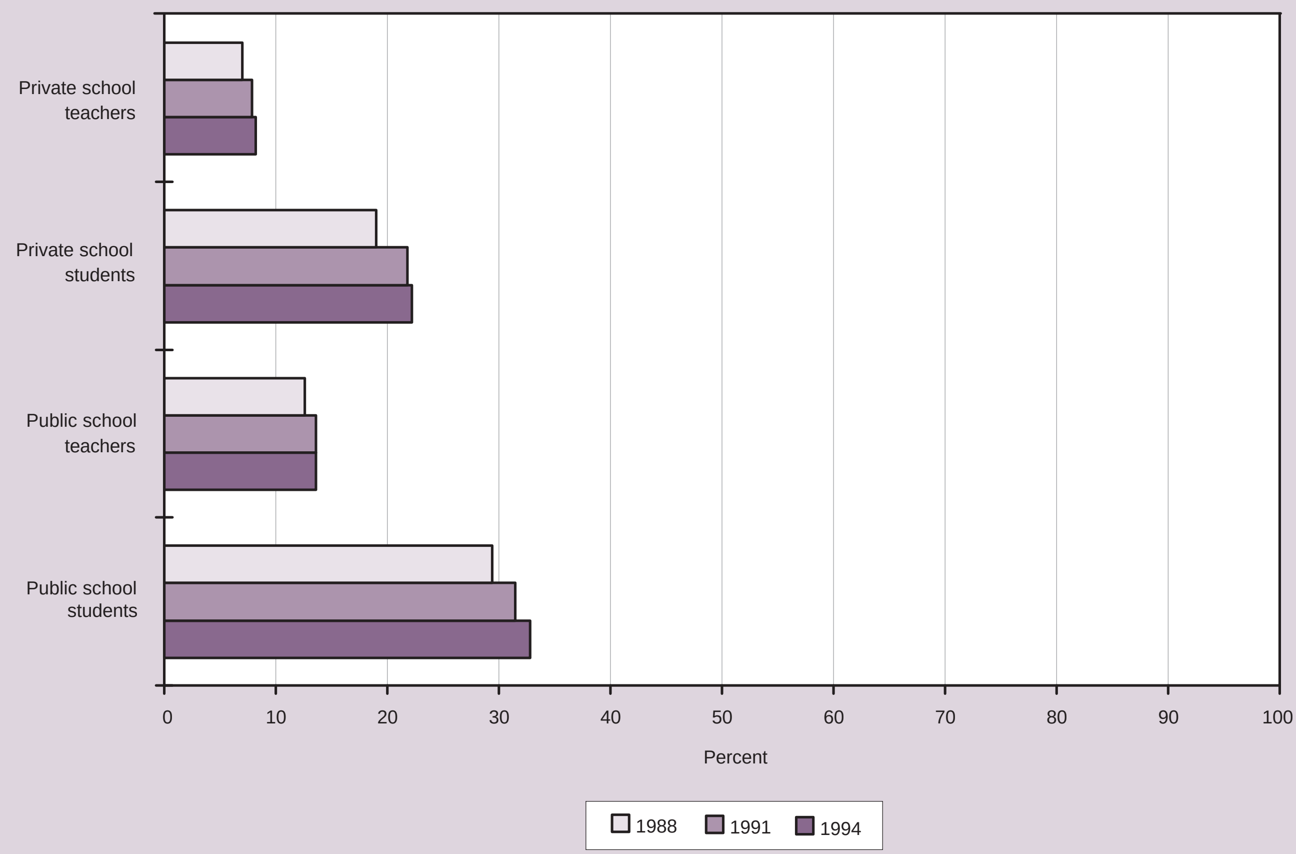
#### School Characteristics

School characteristics contributing to unequal participation in science and mathematics education include tracking, judgments about ability, number and quality of science and mathematics courses offered, access to qualified teachers, access to resources, curricula emphases (Oakes, 1990; Weiss, 1994; Madigan, 1997), and access to teachers and services that reduce language and cultural barriers (Laosa, 1997; Miller, 1997; Ponessa, 1997).

Lack of role models may also influence achievement. The proportion of minority (black, Hispanic, and Asian) students in elementary and secondary schools has increased in recent years from 28 percent in 1987–1988 to 32 percent in 1993–1994. (See appendix table 2-1.) In the 1993–1994 school year, black students constituted 16 percent; Hispanic students, 12 percent; and Asian students, 3 percent of all public and private elementary and secondary school students. The proportion of elementary and secondary teachers who are members of minority racial/ethnic groups was 12 percent in 1987–1988 and 13 percent in 1993–1994—still well below the proportion of minority students. (See figure 2-1 and appendix table 2-2.)

Classroom placement and accommodations are factors that influence the achievement of students with disabilities in addition to factors mentioned previously. Elementary and secondary students with disabilities have special needs that may hinder their ability to participate fully in science and mathematics instruction if accommodations are not made. Students with disabilities may be served in regular classrooms and be provided with special services via a resource room or receive instruction at a variety of special sites. Secondary students who spend more time in regular education and vocational classes have greater access to the general educational curriculum, higher expectations for performance, and more positive school outcomes (U.S. Department of Education, 1996 and 1997). During the past few years, the fraction of students served in regular classrooms has increased and the

Figure 2-1.
**Percentage of students and teachers who are minority, by type of school: 1988, 1991, and 1994**




NOTE: "Minority" includes Asians, Hispanics, blacks, and American Indians.

See appendix tables 2-1 and 2-2.

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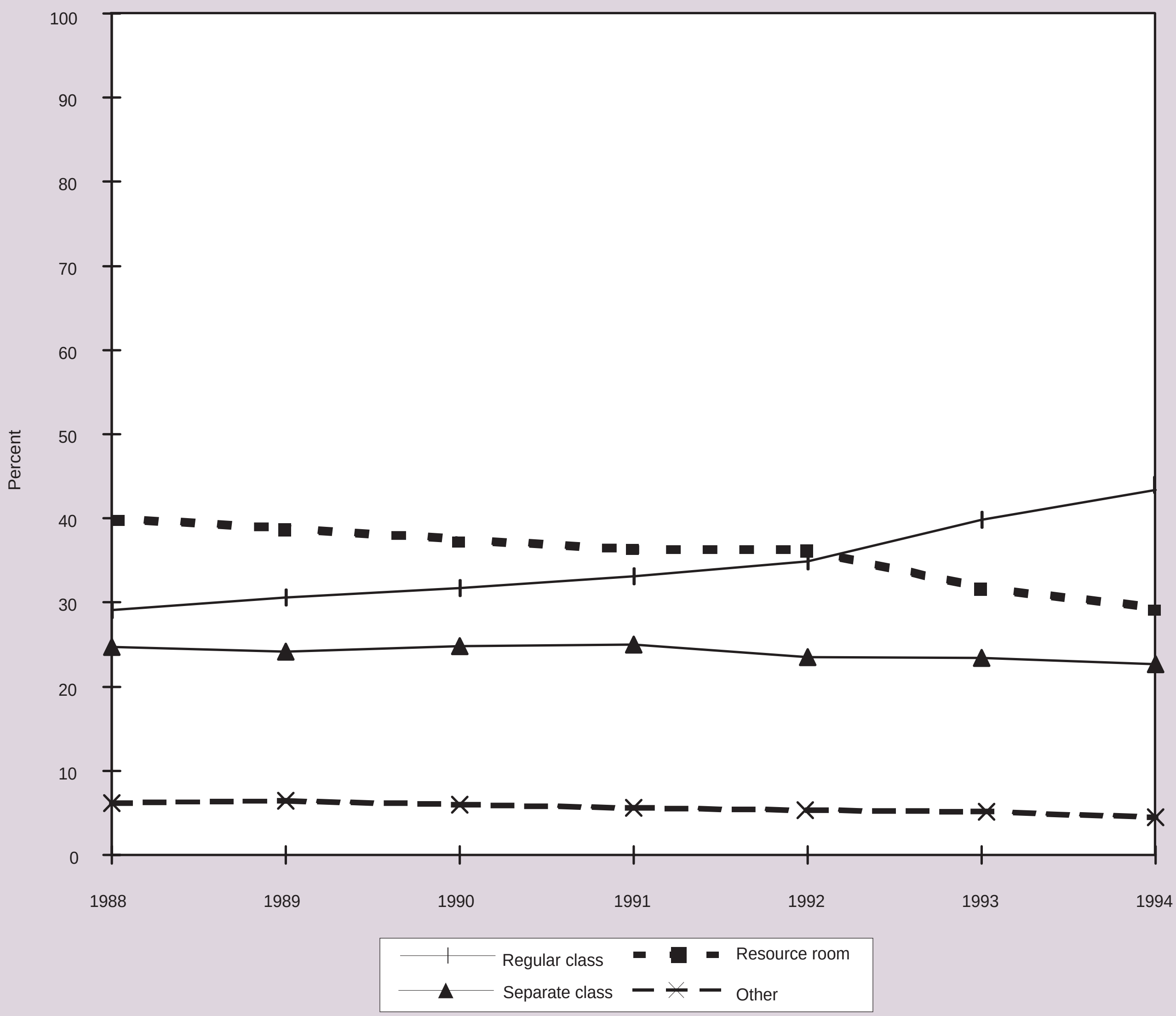
percentage served in resource rooms has decreased. (See figure 2-2.) In the 1993–1994 school year, 43 percent of all students receiving special education services were in regular classrooms (up from 29 percent in 1987–1988), 30 percent were in resource rooms, 23 percent in separate classes, 3 percent in separate schools, and less than 1 percent each in residential facilities or in homebound/hospital placements. (See appendix table 2-3.)

Placement patterns for students vary considerably depending on the type of disability. Students with speech and language impairments are most likely to attend regular classes: 88 percent are in regular classes. Students with learning disabilities, orthopedic impairments, serious emotional disturbance, and traumatic brain injury are more widely distributed in their placements within several settings—regular classes, resource rooms, and separate classes—within regular schools. (See appendix table 2-4.)

Technology in the classroom can also influence instruction of students with disabilities. Advances in technology (for example, closed captioning, personal computers, and Internet services) can allow students with disabilities to communicate and participate in

Figure 2-2.

**Percentage of students ages 6 to 21 with disabilities by type of educational environment: 1988–1994**




See appendix table 2-3.

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## Differences in Student Access to Technology

Students differ in their access to computer technology and in their use of computers, according to the report *Computers and Classrooms* (Coley, Cradler, and Engel, 1997). In general, students attending high-poverty and high-minority schools had less access to computer technology. These schools had fewer computers and multimedia computers per student than other schools and were less likely to have cable TV, access to the Internet, CD-ROM technology, and local area networks. Also, schools with high percentages of minorities were less likely to have satellite dishes. There were two exceptions to the general finding: high-poverty schools were more likely to have satellite dishes and the schools with low percentages of minority students were least likely to have videodisc players.[1]

The Educational Testing Service (ETS) study reported several differences among students in their computer-related coursework or experience (based on a 1996 College Board report on SAT program test takers). Females were slightly more likely than males to have experience in word processing and to use a computer in their English courses. Females were less likely than males to have experience in computer literacy, using computers to solve mathematics problems, and taking courses in computer programming. Blacks and Hispanics were less likely than whites to have experience in word processing, computer literacy, using computers in their English courses, and using computers to solve mathematics problems. Asians were more likely to have taken courses in computer programming.

[1] The data for access to the Internet are for fall 1996 and are reported in the NCES survey report: *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, Fall 1996*, U.S. Department of Education, National Center for Education Statistics, February 1997 (Heaviside, Riggins, and Farris, 1997). The rest are 1995–1996 data reported in *Technology in Public Schools, 15th Edition. Installed Base Technology in U.S. Public Schools, Covering 1981–1996*, 1997, Quality Education Data, Denver, CO (Quality Education Data, 1997).

classroom activities more on par with students who do not have disabilities. Efforts to increase accessibility to persons with disabilities often increases accessibility to others. For example, closed captioning, which was implemented for people who are deaf, is now being used by people learning English as a second language (National Research Council, 1997). Not all of these advances, however, will be accessible by all people in all situations.

# Science and Mathematics Course Taking and Achievement

The number of courses taken in mathematics and science is an important indicator of preparation for undergraduate majors in science and engineering as well as of general scientific literacy and is, as we have seen, an important influence on mathematics and science achievement.

## Women

### *Mathematics Course Taking*

Female and male students are similar in completion of high school mathematics courses. More than half of both male and female high school graduates in 1994 had taken algebra II and geometry, but far fewer had taken trigonometry and calculus in high school. Nevertheless, the same percentages of male and female students had taken these advanced courses: 17 percent of male and 18 percent of female students had taken trigonometry, 9 percent of both had taken calculus, and 7 percent of both had taken advanced placement calculus. (See appendix table 2-5.)

### *Science Course Taking*

Male and female high school students differed only slightly in science course taking in 1994. Female students were slightly more likely than males to have taken biology and chemistry, and males were slightly more likely than females to have taken physics: 92 percent of males and 95 percent of females had taken biology, 53 percent of males and 59 percent of females had taken chemistry, and 27 percent of males and 22 percent of females had taken physics. (See appendix table 2-5.) The increases in physics course taking from 1982 to 1994 were greater for females than for males. During that period, the proportion of male high school graduates who had taken physics increased 8 percentage points (from 19 percent to 27 percent) and the proportion of females who had taken physics increased 12 percentage points (from 10 percent to 22 percent).

### *Mathematics and Science Achievement*

The National Assessment of Educational Progress (NAEP), funded by the National Center for Education Statistics in the U.S. Department of Education, is

## Diversity Among Asian American High School Students

Although Asian Americans are often treated as a single group for statistical analysis, a recent report (Kim, 1997) found many differences in educational and family background among Asian American high school seniors depending on whether they were Chinese, Filipinos, Koreans, Japanese, Southeast Asians, or South Asians.[2] Differences were also found between native-born and foreign-born Asian Americans. Data for the report were drawn from the Second Follow-up Survey of the 1988 National Education Longitudinal Study (NELS:88).[3]

The author of the report, Heather Kim, argues that even though stereotypes of Asian Americans may be largely favorable, they still can be harmful. For example, because there is a widespread belief that Asian Americans are strong academically, there may not be sufficient effort to provide help for those groups of Asian Americans that are less highly educated. She states, "The myth of them all being educational high achievers has kept many from needed student services and support."

In some respects, the six groups of Asian Americans were fairly similar to one another. Nearly all believed that getting a good education was important in their lives. Three-fourths or more of the parents expected their child to earn a college degree or higher.

Parents of South Asian students had the highest occupational status and educational expectations for their children of any of the groups. The South Asian students themselves tended to have the highest educational aspirations, to be more involved in extracurricular activities, and to perform the best on the National Assessment of Educational Progress (NAEP) standardized tests in reading and (to a lesser degree) mathematics. By contrast, the parents of Southeast Asians were the least likely to have a college education and had the lowest occupational status on average. The Southeast Asian students tended to have the lowest educational aspirations, to be least likely to participate in extracurricular activities, and to receive the lowest scores on the NAEP standardized tests.

Native-born seniors tended to have greater educational advantages than foreign-born seniors. Their parents generally had achieved higher educational levels and higher status occupations. Native-born seniors on average spent more time on extracurricular activities than foreign-born seniors but less time on homework. Native-born seniors did better on the NAEP standardized test on reading, but about the same as their foreign-born peers on mathematics.

The ethnicity of Asian Americans and their likelihood of being native born are interrelated. Chinese immigration started earliest (about 1840), followed by the Japanese (between 1890 and 1920), and Korean (about 1903). Thus, among these groups one can expect to find substantial groups of native-born students. By contrast, Southeast Asians are more likely than other groups to be foreign born.

Aside from her use of the NELS data, Kim also cites other statistics concerning the disadvantages facing some Asian ethnic groups. These include high school dropout rates around 50 percent for schools with high concentrations of Southeast Asians and high dropout rates for Filipinos (46 percent) and Samoans (60 percent) in 1992. The median family income in 1990 for all Asian Americans was $41,241 but only $14,327 for Hmongs, $18,126 for Cambodians, and $23,101 for Laotians.

The NELS data are subject to relatively high standard errors because of the small sample sizes for these groups (for example, the total number of Asian Americans was 961, with only 70 Japanese and 97 South Asians in the sample) and clustering can be expected to increase the size of the standard errors further. (For example, many of the Japanese students may attend just a small number of the sampled schools.) Thus, the data are illuminating, but should not be considered definitive estimates. The groups of native-born and foreign-born Asian Americans were roughly equal in size, so the sample size is less of an issue for that portion of the analysis (though clustering remains an issue).

[2] Southeast Asians include Vietnamese, Laotian, Cambodian/Kampuchean, and Thai. South Asians include Asian Indian, Pakistani, Bangladeshi, and Sri Lankan.

[3] The Second Follow-Up Survey of the 1988 National Education Longitudinal Study of 1988 (NELS:88) was conducted in 1992 by the National Opinion Research Center (NORC) at the University of Chicago for the National Center for Education Statistics, U.S. Department of Education.

designed to determine the achievement levels of precollege students in a number of areas, including mathematics and science and to measure changes in achievement over time. Both mathematics and science assessments are administered periodically to students in the 4th, 8th, and 12th grades. National results are reported by NAEP for each grade level and within various subgroups (for example, males and females, racial/ethnic groups).

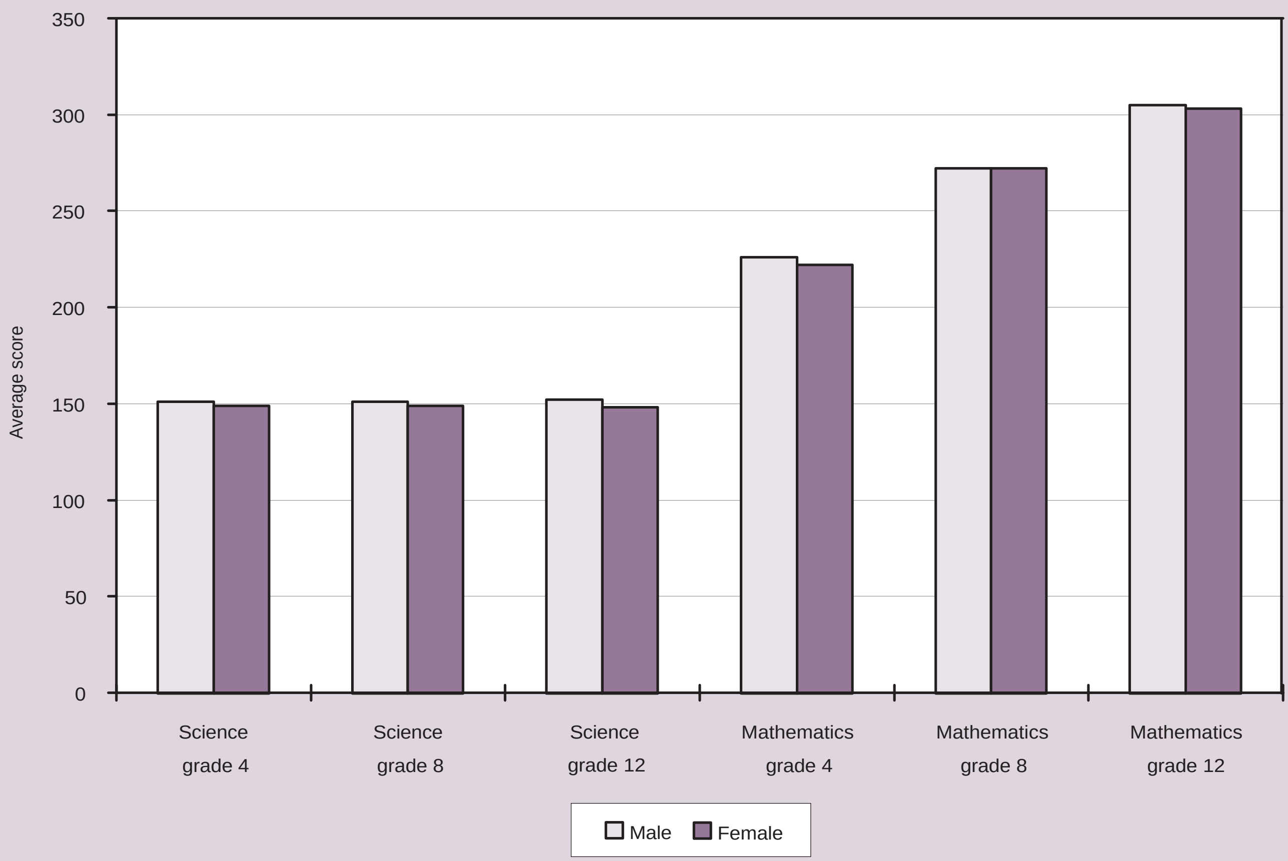
## Mathematics

The 1996 NAEP mathematics assessment measured mathematics performance in five content areas: number sense, properties, and operations; measurement; geometry and spatial sense; data analysis, statistics, and probability; and algebra and functions as well as mathematical abilities (conceptual understanding, procedural knowledge, and problem solving) and mathematical power (reasoning, connections, and communication). Achievement was measured on a scale ranging from 0 to 500.

Results of the 1996 mathematics assessment showed that the gender gap in mathematics achievement is narrowing. (See appendix table 2-6.) Previous NAEP mathematics assessments showed that males scored higher than females in grade 12, but in 1996, average mathematics scores for males and females in 8th and 12th grade were not significantly different. (See figure 2-3.) In 4th grade, the average mathematics assessment score for males (226) was higher than that for females (222). (See appendix table 2-7.) Although the difference is small, it is statistically significant.

Differences remain, however, in the percentages performing at the *proficient* and *advanced* levels of

Figure 2-3.
**Average NAEP mathematics and sciences scores at grades 4, 8, and 12, by sex: 1996**




NOTE: Science scale scores, which range from 0 to 300, were developed independently for each grade assessed. Mathematics scale scores ranged from 0 to 500 across all three grades.

See appendix table 2-6.

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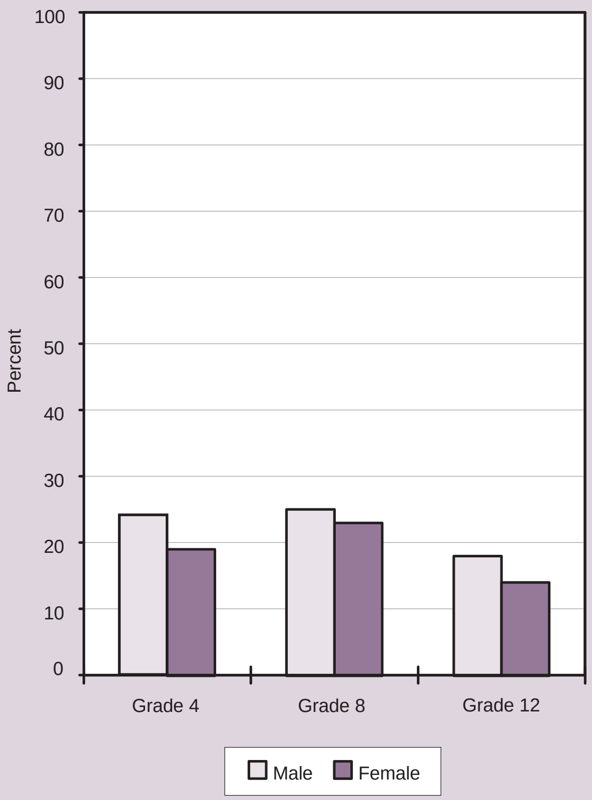
Figure 2-4.
**Percentage of students scoring at or above proficient level on NAEP mathematics assessment in grades 4, 8, and 12, by sex: 1996**




See appendix table 2-8.

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achievement. NAEP developed three achievement levels—basic, proficient, and advanced—to measure level of knowledge and skills. (See sidebar, this page.) Among 8th graders, the differences in the percentages of male and female students at each achievement level were not statistically significant. (See appendix table 2-8.) Among 4th and 12th grade students, however, higher percentages of males than females scored at the *advanced* level and at or above the *proficient* level. (See figure 2-4.)

### Science

The 1996 NAEP science assessment measured achievement on knowledge of facts, concepts, and analytical reasoning skills; abilities to explain, integrate, apply, reason about, plan, design, evaluate, and communicate scientific information; and abilities to use materials to make observations, perform investigations, evaluate experimental results, and apply problem-solving skills. Science achievement was measured on a scale ranging from 0 to 300.

Among 12th graders, female students scored lower than male students on the 1996 science assessment. (See figure 2-3.) Although the average science scores (152 for males and 148 for females) did not differ greatly, the difference is statistically significant. The differences in males' and females' science scores at grades 4 and 8 are not statistically significant.

## NAEP Achievement Levels

*Basic* level—denotes partial mastery of the knowledge and skills that are fundamental for proficient work at a given grade.

*Proficient* level—represents solid academic performance. Students reaching this level demonstrate competency with a range of challenging subject matter.

*Advanced* level—signifies superior performance at a given grade.

These performance levels are cumulative—students performing at the advanced or proficient levels also perform at the immediately preceding levels.

## The International Gender Gap in Mathematics and Science Achievement

The United States is one of many nations worldwide in which the gender gap in mathematics and science achievement has virtually disappeared (Peak, 1997). No statistically significant difference was found between the mathematics scores of 8th grade boys and girls in 33 nations, including the United States, that participated in the Third International Mathematics and Science Study (TIMSS).[4] Further, no statistically significant difference was found between the science scores of 8th grade boys and girls in 11 nations, including the United States, that participated in TIMSS. The 11 nations with no statistically significant gender differences in 8th grade mathematics and science scores were Australia, Columbia, Cyprus, Flemish Belgium, Ireland, Romania, the Russian Federation, Singapore, South Africa, and the United States.

[4] TIMSS was a study of science and mathematics knowledge in 41 nations during the 1995 school year.

## Gender Differences in Attitudes Toward Science and Mathematics

Attitudes toward science and mathematics both reflect and reinforce achievement in these subjects. Those who do well tend to like science and mathematics, and those who like these subjects tend to have higher levels of achievement in them. It is not that surprising then that females' and males' attitudes toward science and mathematics are similar given that their achievement levels are becoming more similar. Results from the 1995 TIMSS study show that for the most part, female and male students in 4th grade and in 8th grade were similar in their attitudes toward science and mathematics.

Among 4th graders in the United States and in many countries, little difference was found in males' and females' self-perceptions of doing well in mathematics (Mullis et al., 1997). Among 8th graders, females and males were about equally likely to like mathematics (Beaton et al., 1996b). In several countries, however, (Austria, France, Germany, Hong Kong, Japan, Norway, and Switzerland) males were more likely to like mathematics than were females. In Ireland, a greater percentage of females than males liked mathematics.

Similarly, among 4th and 8th graders, males and females in most countries that participated in the study (including the United States) did not differ significantly in self-perceptions of doing well in science or in liking science. In Austria, Japan, and Korea, however, a greater percentage of male than female 4th graders liked science, and in Iceland and Ireland a greater percentage of females than males liked science (Martin et al., 1997). Some differences were apparent by subject area, however. Eighth grade males and females differed little in liking of biological science or earth science, but male students in most countries were more likely to like physical science than were females (Beaton et al., 1996a).

## Minorities

### *Mathematics Course Taking*

Although substantial differences in course taking by racial/ethnic groups remain, the percentages of black, Hispanic, and American Indian students taking many basic and advanced mathematics courses have doubled between 1982 and 1994. For example, in 1982, 22 percent of black high school graduates had taken algebra II. By 1994, 44 percent had taken this course. (See figure 2-5.) Similarly, 29 percent of black high school graduates in 1982 had taken geometry, 6 percent had taken trigonometry, and 1 percent had taken calculus. By 1992, these percentages had increased to 58 percent, 14 percent, and 4 percent, respectively. (See appendix table 2-9.)

Despite the gains, racial/ethnic groups differ greatly in mathematics course taking. Black and Hispanic high school graduates in 1994 were more likely than white and Asian students to have taken remedial mathematics courses: 31 percent of black, 24 percent of Hispanic, and 35 percent of American Indian high school graduates, compared with about 15 percent of whites and Asians had taken remedial mathematics in high school. Black and Hispanic high school graduates in 1994 were less likely than white and Asian students to have taken advanced mathematics courses. Although more than 60 percent of both white and Asian students had taken algebra II, 44 percent of blacks, 51 percent of Hispanics, and 39 percent of American Indians had taken this course. Asians were the most likely of any racial/ethnic group to have taken advanced mathematics courses. Almost one-third of Asians had taken precalculus and 23 percent had taken calculus. By contrast, 18 percent of white, 10 percent of black, 14 percent of Hispanic, and 9 percent of American Indians had taken precalculus and less than 10 percent of any of these groups had taken calculus. (See appendix table 2-9.)

### *Science Course Taking*

As is the case with mathematics course taking, blacks, Hispanics, and American Indians are taking more science classes than they took in the past. The percentage of blacks and Hispanics taking chemistry and physics doubled between 1982 and 1994. In 1982, 22 percent of black, 16 percent of Hispanic, and 26 percent of American Indian high school graduates had taken chemistry. By 1994, this had increased to 44 percent, 46 percent, and 41 percent respectively. In 1982, approximately 7 percent each of blacks, Hispanics, and American Indians had taken physics; by 1994, 15 percent of blacks, 16 percent of Hispanics, and 10 percent of American Indians had taken physics. (See appendix table 2-9.)

Despite these gains, the percentage of black, Hispanic, and American Indian students taking chemistry and physics is below the percentage of white and Asian students taking these courses. Fifty-eight percent of white and 69 percent of Asian high school graduates in 1992 had taken chemistry, and 26 percent of white and 42 percent of Asian students had taken physics.

## Mathematics and Science Achievement

### Mathematics

Average mathematics scores have increased for all racial/ethnic groups since 1990, but differences between the scores of white students and black and Hispanic students have not significantly narrowed. For example, among 12th graders in 1990, the average difference between white students' mathematics scores and those of black students was 33 points. In 1996, it was 31 points. (See appendix table 2-7.) The average difference between 12th grade white students' mathematics scores and those of Hispanic students was 25 points in 1990; in 1996, it was 24 points. Differences are as great among 4th graders. In 1996, the average gap in mathematics scores between white and black 4th graders was 32 points, and the average gap between white and Hispanic 4th graders was 26 points.

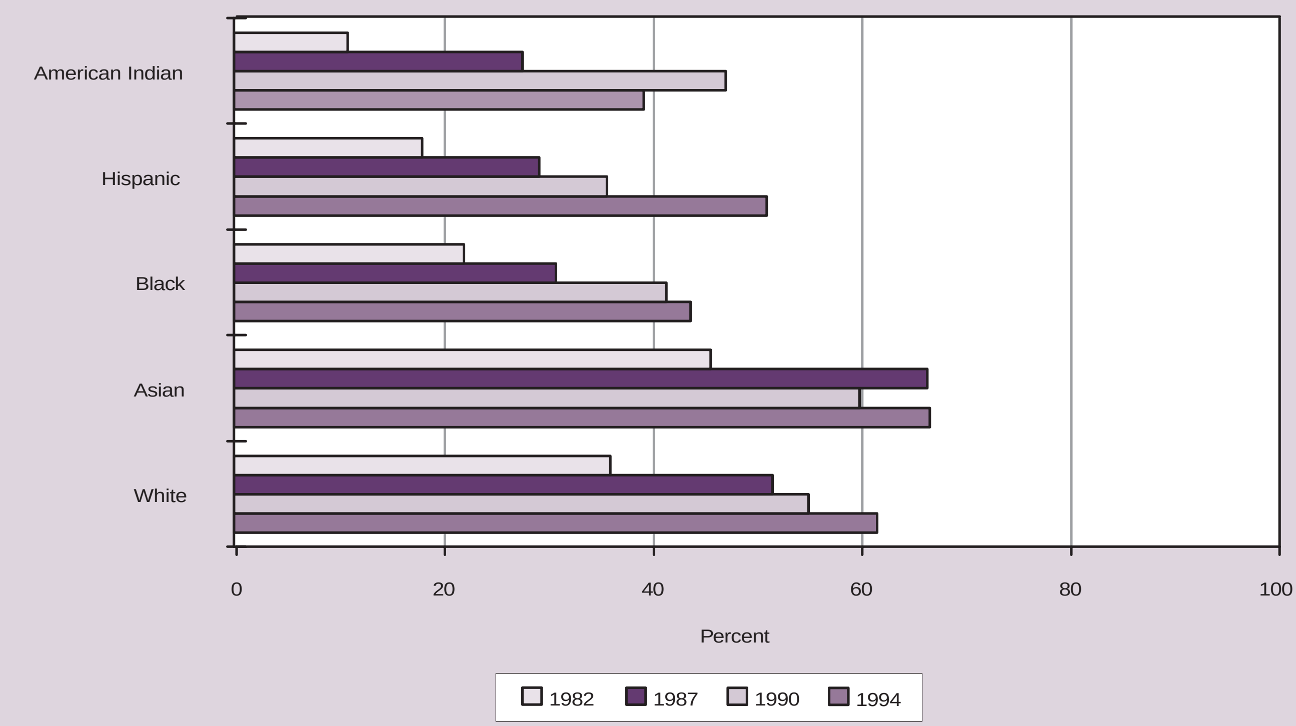
Differences by race/ethnicity also existed in the percentages performing at *proficient* levels in mathematics. Among 4th, 8th, and 12th grade students, more than 20 percent of white students and less than 10 percent of black, Hispanic, and American Indian students scored at or above the *proficient* level. (See appendix table 2-8.) Half, or more than half, of black and Hispanic students at all three grade levels scored below the *basic* proficiency level in mathematics compared with about one-fourth of white students. (See figure 2-6.)

### Science

As with mathematics scores, differences in science scores persist across racial/ethnic groups. Scores for white, Asian, and American Indian students are substantially higher than those for black and Hispanic students in grades 4, 8, and 12.[5] (See figure 2-7.) Among 12th graders in 1996, average science scores were 159 for whites, 149 for Asians, 145 for American Indians, 130 for Hispanics, and 124 for blacks.

[5] An accurate determination of the standard error associated with the average scale score for 12th grade American Indian students was not possible; therefore differences between this group and other groups at grade 12 should be interpreted with caution.

Figure 2-5.
**Percentage of high school graduates taking algebra II in high school, by race/ethnicity: 1982, 1987, 1990, and 1994**




See appendix table 2-9.

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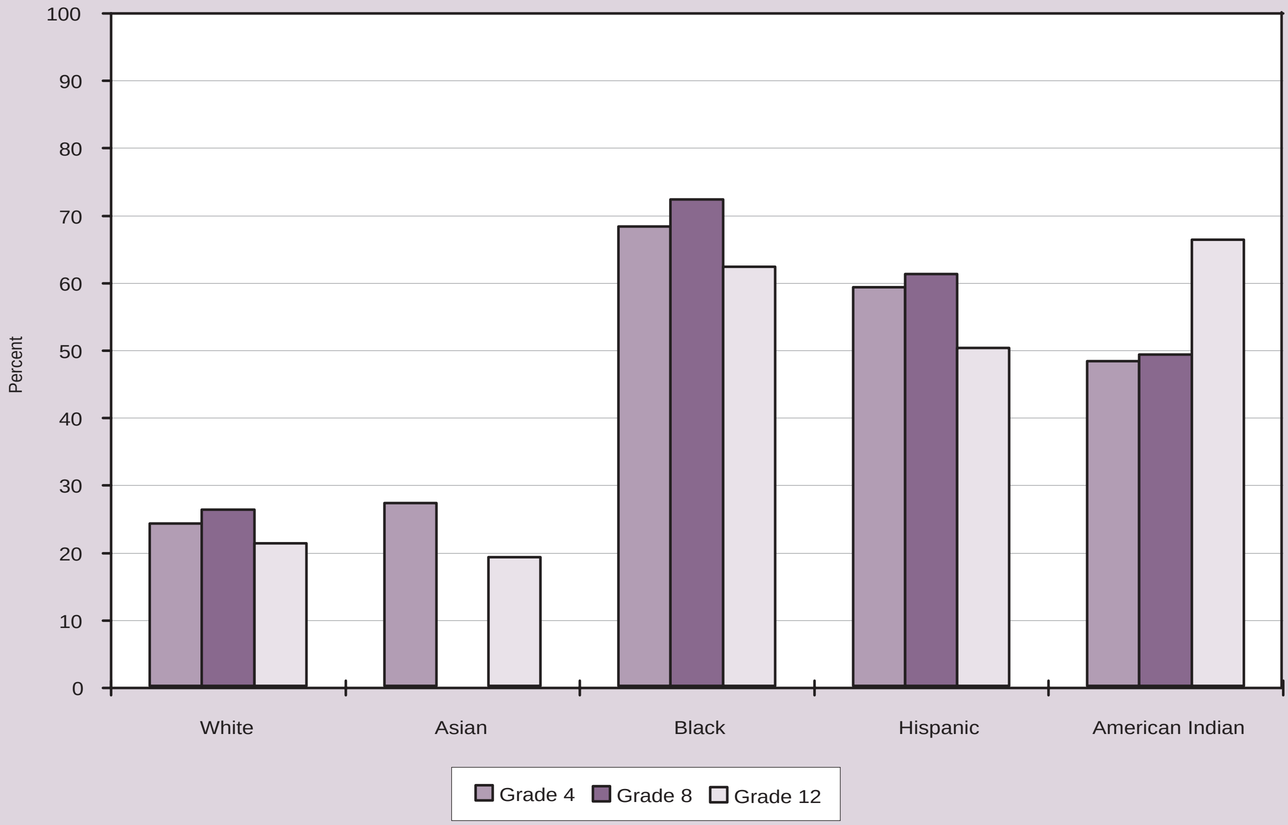
Figure 2-6.
**Percentage of students in grades 4, 8, and 12 scoring below the basic proficiency level in mathematics, by race/ethnicity: 1996**




NOTE: Results for 8th grade Asian students not available.

See appendix table 2-8.

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## Students With Disabilities

### *Variations in Estimates of the Number of Students With Disabilities*

Determining the number of students with disabilities is challenging given variations in age ranges of the population, in definitions, in data collection procedures, and in the individual reporting the disability (for example, student, parent, teacher, school official) (Rossi, Herting, and Wolman, 1997). For differences in prevalence and classification from various sources, see text table 2-1.

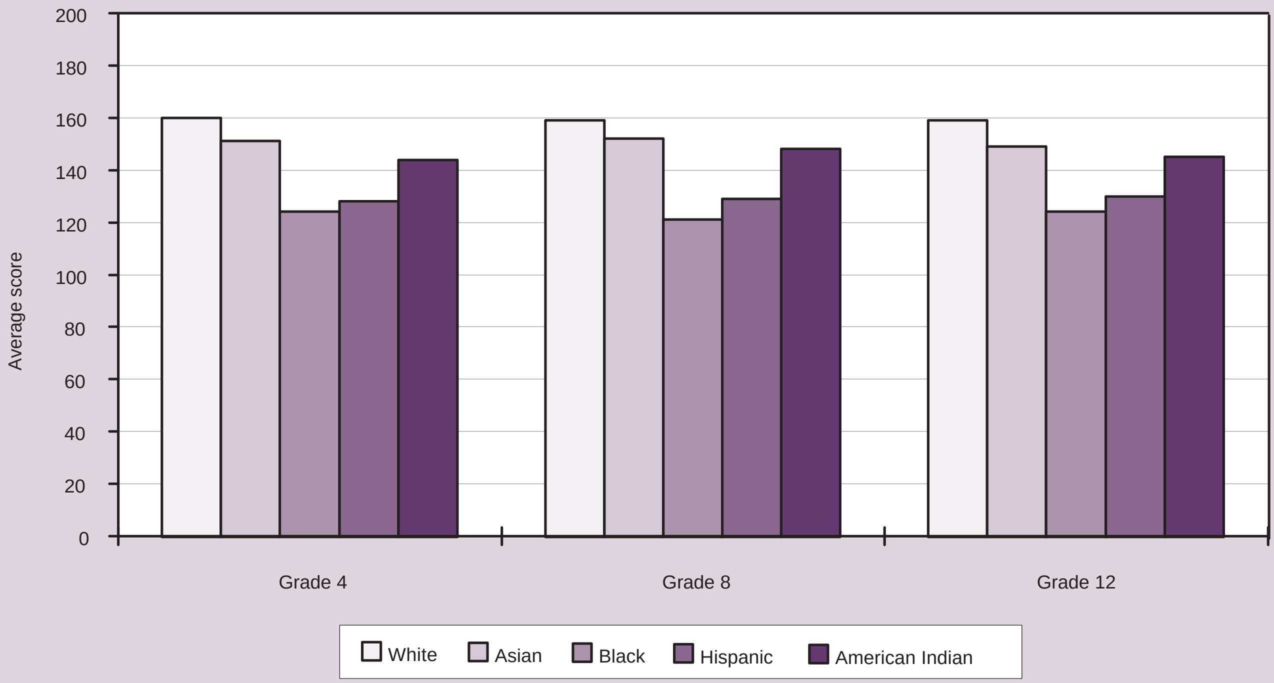
According to the Department of Education's Office of Special Education and Rehabilitative Services, the percentage of children enrolled in school and between the ages of 6 and 17 who were served in Federally supported special education programs was 10 percent in 1994–1995.[6 7 8] Eight percent of all children ages 6 through 21 were served in these programs. Fifty-one percent of the children age 6 through 21 with disabilities had specific learning disabilities, and another 21 percent had speech or language impairments. (See appendix table 2-10.) About 12 percent were mentally retarded, 9 percent had a serious emotional disturbance, 2 percent had "other" health impairments, and 1 percent each had

[6] It should be noted that not all children with impairments require special education.

[7] The data collected by the Office of Special Education and Rehabilitative Services are the only data collected specifically to provide counts of students eligible to receive services.

[8] The Individuals with Disabilities Education Act (IDEA), Part B, requires that "all children and youth with disabilities have access to a free appropriate public education that is determined on an individual basis and designed to meet their unique needs" (Barbett and Korb, 1997).

Figure 2-7.
**Average NAEP science scores at grades 4, 8, and 12, by race/ethnicity: 1996**




NOTE: Science scale scores, which range from 0 to 300, were developed independently for each grade assessed.

See appendix table 2-6.

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mobility or hearing impairments. Visual impairments, autism, deaf-blindness, and traumatic brain injury each accounted for less than 1 percent of the students with disabilities.

Students participating in Federal programs for children with disabilities have been increasing both in number and as a fraction of total public school enrollment. Between 1977 and 1995, the number of students who participated in Federal programs for children with disabilities increased 47 percent, from 3.7 million to 5.4 million students. Part of this growth is due to an increase in the number of students identified with specific learning disabilities. Students with specific learning disabilities increased from approximately 800,000 students or 2 percent of total public K–12 enrollment in 1977 to 2.5 million students or 6 percent of total public K–12 enrollment in 1995. The number of students with other types of disabilities (with the exception of students with serious emotional disturbance) went down during that time period (U.S. Department of Education, 1997).

Students with disabilities made up 11 percent of students in grade 4, 9 percent of students in grade 8, and 5 percent of students in grade 12 in 1996 (Reese et al., 1997). These students take fewer science and mathematics courses, have lower grades, and have lower achievement scores than students without disabilities.

## Mathematics and Science Course Taking

Twelfth-grade students with disabilities[9] earned fewer credits in mathematics in 1992 than did those without disabilities. (See appendix table 2-11.) Differences are not great by type of disability. Students with disabilities also earned fewer science credits than those without disabilities. (See appendix table 2-11.)

## Mathematics and Science Achievement

Students with disabilities have lower average high school grades in mathematics and in science than those without disabilities. (See appendix table 2-11.)

[9] Students were identified by their parents as being disabled. The source of these data is the National Center for Education Statistics, National Education Longitudinal Study, 1988.

Text table 2-1.
**Data sets on disability prevalence among children in the United States[1]**

| 1988 NELS (8th grade)[2] | | | HS & B (10th grade)[3] | | | 1988 NAEP (age 13)[4] | | 1992 CPS (age 5–17) | | 1988 NHIS/CH Under age 18)[5] | | 1994 OSEP (age 6–21)[6] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Classification (Parent report) | % with condition | % received services | Classification (student report) | % 1980 | % 1982 | Classification | % | Classification | % | Classification | % | Classification | % |
| Mental retardation | 0.1 [3.1][7] | 0.0 | | | | Mentally retarded | 1.0 [20.4] | Mental retardation | 0.7 | Delay in growth or development | 4.0 | Mental retardation | 0.9 |
| Specific learning problem | 6.1 | 7.6 | Specific learning disability | 2.6 | 1.7 | Learning disabled | 2.1 [43.5] | Learning disability | 4.3 | Learning disability | 6.5 | Specific learning disability | 4.1 |
| Emotional problem | 2.8 | 2.6 | | | | Emotionally disturbed | 0.3 [6.1] | Serious emotional disturbance | 0.9 | Emotional or behavioral problem (age 3-17) | 6.1 | Serious emotional disturbance | 0.7 |
| Speech problem | 1.6 | 6.9 | Speech disability | 1.6 | 1.1 | Speech impaired | 0.1 [1.3] | Speech impairment | 2.5 | Speech impairment | 2.6 | Speech or language impairment | 1.7 |
| Hearing problem | 2.2 | 1.9 | Hard of hearing | 2.2 | 1.8 | Hard of hearing | 0.0 [0.5] | Other hearing impairment | 1.2 | Deafness and hearing loss | 1.5 | Hearing impairment | 0.1 |
| Deafness | 0.4 | 0.3 | Deafness | 0.4 | 0.5 | Deaf | 0.0 [0.2] | Deafness | 0.4 | | | | |
| Visual handicap (not correctable with glasses) | 1.6 | 1.1 | Visual handicap[8] | 1.6 | 1.5 | Visual handicap/ blind | 0.0 [0.2] | Other visual impairment | 1.8 | Blindness and vision impairment | 1.3 | Visual impairment | <0.1 |
| | | | | | | Deaf/blind | 0.0 [0.1] | Blindness | 0.3 | | | Deaf-blindness | 0.0 |
| Orthopedic problem | 0.9 | 1.1 | Orthopedic problem | 1.3 | 0.9 | Orthopedically impaired | 0.0 [0.7] | Orthopedic impairment | 1.0 | Musculoskeletal impairments | 1.5 | Orthopedic impairment | 0.1 |
| Other physical disability | 1.1 [0.4][7] | 0.8 | Other health impairment | 2.0 | 2.6 | Multidisabled | 0.2 [3.2] | Other health impairment | 1.9 | | | Multiple impairment | 0.2 |
| Any other health problem | 3.7 | 2.3 | | | | Other | 0.3 [5.5] | | | | | Other health impaired[9] | 0.1 |
| Total | 15.9[10] | 19.5[10] | | 11.7 | 10.1 | | 4.0 | | 15.0 | | 23.5 | | 8.0 |

NOTES:

[1] Data sets include National Educational Longitudinal Study (NELS), 1988; High School and Beyond (HS&B), 1980 and 1982 sophomore cohort; National Assessment of Educational Progress (NAEP), 1988, 13-year-olds; Current Population Survey (CPS), 1992 October Supplement on School Enrollment; National Health Interview Survey on Child Health (NHIS/CH), 1988; Office of Special Education Programs (OSEP) State-reported data. Data and notes for NAEP, CPS, and NHIS/CH were abstracted from Westat, Inc. (1994).

[2] NELS:88 data are derived from the base-year parent survey as follows: Weighted percentages in first column (% with condition) are derived from variable BYP47; weighted percentages in the second column (% received services) are derived from variable BYP48. The unbracketed percentages in these columns include only those students who were included in the 1988 base-year parent survey. They do not include students who were judged ineligible to participate in the base-year survey (i.e., the base-year ineligible, or BYI, students described in the last section of this appendix). These students are shown in the bracketed percentages, as explained in note 7 below.

[3] HS & B data abstracted from Owings, J. and Stocking, C. (1985).

[4] Bracketed figure is the disability prevalence among the approximately 5 percent of students excluded from NAEP because of physical disability, mental disability, or language problem. Approximately 79 percent of excluded 13-year-olds had a disability; the remainder had only a language problem. The first, unbracketed, percentage figure is the number of excluded students with a disability as a percent of total students. (In 1988, NAEP collected no data on the specific disability categories of included students.)

[5] The first three items: Delay in growth or development, Learning disability, and Emotional or behavioral problem (age 3–17) include children who have ever had the condition (lifetime prevalence). Concerning the third, when two additional questions are included: Has the child ever been treated for any emotional, mental, or behavioral problem or ever had anyone suggest that the child needed such treatment, the rate increases to 13.4 percent. The remaining items come from the Child Health questionnaire for chronic conditions, and the rates are conditions per 100 persons rather than percent of persons. A person may have more than one condition per category, especially Musculoskeletal impairments, which consists of many subgroups; so the condition rate may exceed the number of separate individuals involved.

[6] Data from table AA25 in the Sixteenth Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (OSEP 1994). Data are based on counts of students, ages 6–21, served in special education programs under IDEA, Part B, and chapter 2 of ESEA (SOP/State Operated Programs), as a percentage of U.S. Census Bureau estimates of resident populations, by state, for July 1992. This excludes children and disabilities unrelated to special education needs as defined by the federal disability categories.

[7] The bracketed percentages for the categories Mental retardation and Other physical disability reflect the percent of students, in terms of the total population, who were judged to be ineligible to participate in the base-year NELS: 88 survey on the basis of mental or physical disability (i.e., BYI sample).

[8] In the 1982 survey, “not correctable with glasses” was added to the definition.

[9] Other health impairments include Autism and Traumatic brain injury (categories added under IDEA in 1990).

[10] Each NELS:88 “total” is the total weighted percentage of students whose parents indicated they have one or more disability-related problems (first column) or have ever received services for one or more disability-related problems (second column). These percentages are smaller than the sums of the individual column percentages because parents attributed more than one disability-related problem to some students (i.e., adding the column percentages would have produced duplicated counts).

SOURCE: Rossi, Herting, and Wolman (1997, table A.3).

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## Federal Definitions of Special Education Disability Categories

**Specific learning disability.** A disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, write, spell, or do mathematical calculations; this includes perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia, but does not include learning problems resulting from visual, hearing, or motor handicaps, or from mental retardation.

**Seriously emotionally disturbed.** Exhibition of behavior disorders over a long period of time that adversely affect educational performance; this includes an inability to learn that cannot be explained by intellectual, sensory, or health factors; an inability to build or maintain satisfactory interpersonal relationships with peers and teachers; inappropriate types of behaviors or feelings under normal circumstances; a general pervasive mood of unhappiness or depression; or a tendency to develop physical symptoms or fears associated with personal or school problems.

**Speech impaired.** Communication disorders, such as stuttering, impaired articulation, and language or voice impairments, that adversely affect educational performance.

**Mentally retarded.** Significantly subaverage general intellectual functioning with concurrent deficits in adaptive behavior that were manifested in the development period and that adversely affect educational performance.

**Visually impaired.** A visual impairment that, even with correction, adversely affects educational performance, including students who are partially sighted or completely blinded.

**Hard of hearing.** A hearing impairment, permanent or fluctuating, that adversely affects educational performance but that is not included in the deaf category.

**Deaf.** A hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification, which adversely affects educational performance.

**Orthopedically impaired.** A severe orthopedic impairment that adversely affects educational performance, including those caused by congenital anomaly, disease, or other causes.

**Other health impaired.** Limited strength, vitality, or alertness due to chronic or acute health problems that adversely affect educational performance (includes autistic students).

**Multiply handicapped.** Concomitant impairments, the combination of which causes such severe educational problems that they cannot be accommodated in special education programs solely for one of the impairments (does not include deaf/blind).

**Deaf/blind.** Concomitant hearing and visual impairments, the combination of which causes such severe communication and other developmental and educational problems that they cannot be accommodated in special education programs solely for deaf or blind students.

SOURCE: U.S. Department of Education, Office of Special Education Programs. 1991. *Youth With Disabilities: How Are They Doing? The First Comprehensive Report from the National Longitudinal Transition Study of Special Educational Students.* Menlo Park, CA: SRI International, pp. 2–3.

Twelfth grade students with disabilities scored lower than those without disabilities on standardized cognitive tests of mathematics proficiency[10] and had less gain in scores from 1988 to 1992 than students without disabilities. Students with disabilities were more likely than those without disabilities to score in the lowest proficiency levels on these tests. (See appendix table 2-12.) Students with multiple disabilities and students with learning disabilities scored at the lowest performance levels. Students identified as having health problems had 1992 proficiency scores similar to students without disabilities and had gains in proficiency from 1988 to 1992 similar to those without disabilities.

## High School Completion

Racial/ethnic and disability status differences in high school completion rates contribute to differences in college enrollment. (Women are as likely to graduate from high school as men—among people age 25 or older, 82 percent of both men and women graduated from high school.) Among all people age 25 or

[10] These tests were administered to all NELS:88 student participants in 1992. The most severely disabled students were excluded from this survey.

## Increasing the Inclusion of Students With Disabilities in Science and Mathematics Assessments

Students with disabilities were often excluded from the National Assessment of Educational Progress (NAEP) in the past because State and local policies often excluded them from testing, school staff may have believed they were unable to participate fully, and no accommodations were available that met the needs of their legally required Individualized Education Plans. Half or more than half of students with disabilities were excluded from NAEP assessments before 1995.

The 1996 NAEP science and mathematics assessment explored the effects of various mechanisms to increase the participation of students with disabilities in the national assessments. Exclusion or inclusion rules were changed to be clearer, rules were more inclusive and more likely to be applied consistently, and accommodations were provided, including "provision of large-print booklets and large-face calculators, provision of Braille booklets and talking calculators, and accommodations in administration procedures (e.g., unlimited testing time, individual or small-group administrations, allowing a facilitator to read directions, allowing students to give answers orally, allowing students to give answers using a special mechanical apparatus)" (Olson and Goldstein, 1996, p. 5).

Before these modifications can be implemented as official policy, several statistical and measurement issues need to be addressed. One of the issues to be addressed is the effect of accommodations or adaptations on measurement of trends in achievement. Inclusion of additional students and improved testing of students with disabilities who have in the past been assessed under standard conditions complicates the interpretation of trend results. Another issue is the comparability of results of students included and assessed with accommodations to those from other students. The special sample design developed for the 1996 NAEP assessment will allow these issues to be examined.

older in 1995, 86 percent of non-Hispanic whites, 74 percent of non-Hispanic blacks, and 53 percent of Hispanics were high school graduates. (See appendix table 2-13.)

Gains in high school completion by blacks in recent years have narrowed the educational gap. In 1975, 87 percent of whites and 71 percent of blacks in the 25 to 29 age group had completed high school. By 1995, 92 percent of whites and 87 percent of blacks in that age range had completed high school.

Hispanics (of any race) have the lowest high school completion rates and have experienced the least gains over time. In 1995, 57 percent of those in the 25 to 29 age group were high school graduates, a modest increase from 53 percent in 1975. The low high school completion rates are partly explained by the large number of foreign-born Hispanics who entered the United States without a high school education. The lower high school completion rates for blacks and Hispanics may also be related to family income. Youths between the ages of 16 and 24 who lived in families with low income levels were eight times more likely to drop out than those from families with higher incomes (McMillan and Kaufman, 1997).

Students with disabilities have an annual dropout rate of 5 percent. Students with disabilities who drop out of school are less likely than those without disabilities to eventually receive high school diplomas or certificates. Drop out and graduation rates vary by type of disability, with those with visual and hearing impairments most likely to have graduated with a diploma. Those with serious emotional disturbances are most likely to have dropped out. (See appendix table 2-14.)

### Transition to Higher Education

The United States has one of the highest rates in the world of secondary students who go into higher education and earn college degrees (National Science Board, 1998). The transition from secondary school to college is an important step, not only to the person making it, but also to a nation committed to the education of its citizens in a technological world. This section analyzes data primarily on high school seniors who graduated in 1996, many of whom will earn a college degree in the year 2000.

Usually, many people are involved in the student's decision to attend a college—students and their parents, along with guidance counselors and teachers. For students from low-income families, however, guidance counselors, teachers, friends, and youth leaders are almost as important as parents in helping to make decisions about post-high-school plans (Gallup International Institute, 1996.) These individuals help students to assess their strengths and weaknesses and to clarify their goals; the earlier in high school they are discussed, the more successful students are in attaining their goals

(Rodriguez, 1993). Taking assessment tests during high school also helps students ascertain their strengths and weaknesses and choose suitable colleges.

Several organizations are also involved in assessing student aptitude or achievement. In 1900, the College Board was founded as a national membership association of schools and colleges. The College Board currently administers the Advanced Placement, the Preliminary SAT (PSAT), and the SAT tests through the Educational Testing Service. In 1961, American College Testing (ACT) was founded to measure students' educational development through the ACT Assessment. None of these tests individually provides data that can be considered nationally representative of all college bound seniors, because students in different states tend to take either the SAT or the ACT (see sidebar on State-by-State breakout of SAT or ACT on page 29), but they do provide information on the transition from high school to college.

Almost three-fourths of high school seniors take either the SAT or the ACT in preparation for applying to college.[11] Results of these exams are important to students for planning purposes and to colleges for admissions purposes. It is important to note, however, that many students who go to 2-year colleges do not take either test, and that approximately 10 percent of 4-year colleges indicate that SAT and ACT scores are optional for admission (calculation by NSF/SRS based on data from National Center for Fair & Open Testing 1997 and from National Center for Education Statistics 1997 IPEDS surveys, unpublished tabulations).

It is important to note that although test scores can help evaluate a student's academic preparedness in terms of strengths and weaknesses, "directors of admission say that high school grades are still the most important factor in the selection of a freshman class" (College Board, 1997b, p. 4). The percentage of college admissions directors who indicated that school achievement was very important was 87 percent, compared with 46 percent who indicated that test scores were very important; however, highly selective colleges may base admissions on formulas in which standardized test scores account for as much as two-thirds of the calculation (Hernandez, 1997). Although they do not measure many characteristics necessary for success in college, such as motivation, creativity, and persistence, admissions tests are designed to provide a consistent measure across the variety of curricula and opportunities offered in U.S. high schools.

## Women

Women accounted for the majority of test-takers of the Advanced Placement (see page 28) tests (55 percent), the SAT (53 percent), and the ACT (55 percent) in 1996. The number of women taking these tests has increased considerably in the 1990s, and women are also increasing their performance on the tests. In fact, they provide most of the increases seen in total test scores for the ACT and over half in the SAT since 1991,

[11] National Center for Education Statistics, NELS:88, Data Analysis System, unpublished tabulation.

## The ACT

The ACT Assessment Test is a 2-hour 40-minute, multiple-choice examination administered five times a year by the American College Testing Program in Iowa. According to ACT, the test is designed to measure critical reasoning and higher order thinking skills in four curriculum areas—English, mathematics, reading, and science. The composite score is an average of the scores on each of the components on a scale from 1 to 36, with a mean of 18 for the sample of students who take the test nationally. Scores must be different by more than 0.2 points to be significant at the 95 percent level of confidence.

ACT states that these tests reflect students' skills and achievement levels as products of their high school experience and serve as measures of preparation for academic work in college. ACT results are used by postsecondary institutions for admissions, academic advising, course placement, and scholarships. A Federal court has faulted colleges in Mississippi, however, for basing student aid awards on cut-off scores from the ACT because it restricts black students' access to predominantly white colleges (Healy, 1997).

Most students take the test in their junior year of high school. (There is a P-ACT+ test offered that helps students to become familiar with the test format before taking the ACT.) The students who take the ACT are self-selected and do not represent the entire population of college-bound students. Further, the percentage of students who take the ACT, as opposed to the SAT, varies considerably by State. (See sidebar on page 29.) Many factors—such as motivation to learn, parental support, the quality of teaching, socioeconomic status—contribute to individual and group achievement scores (American College Testing, 1996).

## The SAT

The SAT is a 3-hour, primarily multiple-choice test that measures verbal and mathematical reasoning abilities. According to the SAT Program, it is related to successful freshman performance in college and is intended to supplement the high school record and other information about the student in assessing readiness for college-level work. Over the years, the average SAT scores have drifted downward from 500 on both sections to 424 on the verbal and 478 on the mathematics sections. The main reason average SAT scores have drifted is the dramatic expansion in the number of test takers from 10,000 in its beginning to over 1 million now. Beginning in April 1995, the SAT scores were "recentered" to 500 as the midpoint of the 200–800 scale for both the verbal and mathematics portions. All tables in this report use the recentered scores that have been calculated by the College Board for earlier years. The College Board has studied the complex area of how well the SAT predicts freshman grades. (College Board, 1996d).

Text table 2-2.
**Average test scores for college-bound seniors, by sex: 1991 and 1996**

| Sex | SAT | | | | ACT | |
|---|---|---|---|---|---|---|
| | Verbal | | Mathematics | | Composite | |
| | 1991 | 1996 | 1991 | 1996 | 1991 | 1996 |
| Women........ | 495 | 503 | 482 | 492 | 20.4 | 20.8 |
| Men............ | 503 | 507 | 520 | 527 | 20.9 | 21.0 |

NOTE: Scores for the 1991 SAT have been converted to the recentered scale.

SOURCES: College Board and American College Testing tabulations, 1996.

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although men have increased their scores also. (See text table 2-2.)

The ACT score changes show greater progress for women, as the overall gap in composite scores between men and women narrowed from 0.5 points in 1991 to 0.2 points in 1996, not a significant difference. The SAT scores indicate that women have made greater progress than men from 1991 to 1996 in both verbal and mathematics mean scores. In this period, the mean scores changed in the following ways:

- verbal increased 8 points for women and 4 points for men;
- mathematics increased 10 points for women and 7 points for men.

Even with this progress for women, women's scores on average are lower than men's in 1996 on the SAT. Two ways in which men and women taking the college placement tests differ are in their socioeconomic characteristics and type of coursework taken in high school.

### *Socioeconomic Differences*

From the SAT and ACT student data, it is clear that a larger number of women than men from lower income families choose to take college entrance tests. Although the proportions of test takers from the higher family income groups were about evenly split between males and females, among the lowest income groups, women accounted for over 60 percent of the test takers. (See appendix table 2-15.) Given that parental income is related to average scores (College Board, unpublished tabulations), then this fact would mean that the higher proportion of women test takers who are from low-income families would likely reduce the overall averages for women test takers.

### *Course-Taking Differences*

Do course-taking differences account for test score differences among groups? This was believed earlier, as a 1987 National Academy of Sciences report stated that "The general consensus is that these gender differences in college admission mathematics test scores can be largely accounted for by differences in the amount of mathematics, physical science, and computer programming courses that high school and college-bound women take compared to their male peers" (LeBold, 1987, p. 67). More recent studies have shown that although this is a small part of the explanation, there is "the need for more comprehensive research on gender, race, and SES [socio-economic status] differences in science achievement growth" (Madigan, 1997, p. 12).

Differences between quantitative course taking by female and male high school students have lessened in the 1990s, as shown in earlier sections of this report. Similar proportions of women and men took honors mathematics and science classes (29 percent) according to SAT data for 1996 college bound seniors. (See appendix table 2-16.) In terms of level of classes taken, the percentages of women and men taking higher level mathematics were nearly the same. Only small gaps remained between the percentages of men and women who had taken trigonometry (2 percent), precalculus (3 percent), and calculus (4 percent). In science classes, similar percentages of both men and women had taken biology and chemistry; however, a larger gap existed in the percentage who had taken physics (9 percentage points higher among men than women) (College Board, 1996, SAT unpublished tabulations).

The reduction in differences in mathematics course taking leads to the question, Are the average mathematics scores of men and women who took the same level mathematics class more similar? At the lower mathematics level classes (geometry and trigonometry), differences in the mean SAT scores of men and women persist but are smaller than differences at the higher level classes, such as calculus, according to both SAT and ACT data.

An examination of SAT mathematics test scores for only the students who reported taking the highest level of mathematics (calculus) and science (physics) showed that women scored lower on average than men. Among those who took calculus, women averaged 594 and men 631 on the SAT mathematics test; this difference—37 points—is similar to that for men and women test takers in general (35 points difference). Among those who took physics, women averaged 542 and men 577—a 35-point gap (College Board, 1996, SAT unpublished tabulations).

ACT data also show that women who took calculus and physics reported higher grade point averages than men in their high school mathematics and science classes. In the ACT mathematics and science test sections, however, the average scores of women were also lower than those of men. (See text table 2-3.)

Educators and researchers in both the academic community and within the testing organizations have been concerned about the underlying reasons for this disparity. In 1997, ETS released a study (Cole, 1997) that had three interesting results that pertain to this issue.

- In nationally representative samples of 12th graders, "the spread of scores of males tends to be larger than the spread for females. This means that there are more males among the very highest scorers and also more males among the very lowest scorers. Below the 10th percentile and above the 90th percentile, there are about 4 females for every 5 males. We see this low-end result perhaps in the presence of more males in some special education classes…. The high-end result is especially important for self-selected groups, such as those taking high-stakes tests. These groups [students taking the SAT] come from the high end of the distribution and, all other things being equal, we can expect more males than females among such groups and higher average scores for males than for females among such groups" (pp. 16–18).
- Tests measure particular skills on a single day, whereas grades measure a much wider array of skills. "In fact, we view grades as likely measuring a constellation of desirable characteristics that we call 'studenting skills'—skills that are especially valuable in school or in work. These skills may include characteristics such as persistence, follow-through, doing required work, participating, and performing in different contexts…. Years of results in predicting college grades have, for example, shown that grades are most often the single best predictor…. Also, tests have consistently been shown to add to the prediction of college performance beyond that accomplished by grades alone." (See sidebar on SAT, page 25.)

  For example, were the SAT used alone, it would slightly underpredict the overall grade-point average of first-year female college students…. One subject, calculus, has yielded larger differences than…most other subjects examined. Earlier results had indicated…underprediction of college calcu-

Text table 2-3.
**ACT mathematics and science reasoning scores and GPA for women and men who had taken calculus and physics in high school: 1996**

| High school class | Women | Men |
|---|---|---|
| Calculus: | | |
| Mathematics GPA……..…… | 3.02 | 2.94 |
| | 30,555 | 26,922 |
| Mean score…………..…… | 24.10 | 25.40 |
| Physics:[1] | | |
| Science GPA……………… | 3.15 | 3.04 |
| | 139,084 | 133,105 |
| Mean score………………. | 22.00 | 23.50 |

[1] Students who had taken general science, biology, chemistry, and physics.

SOURCE: American College Testing, 1996 Profile Report, unpublished tabulations.

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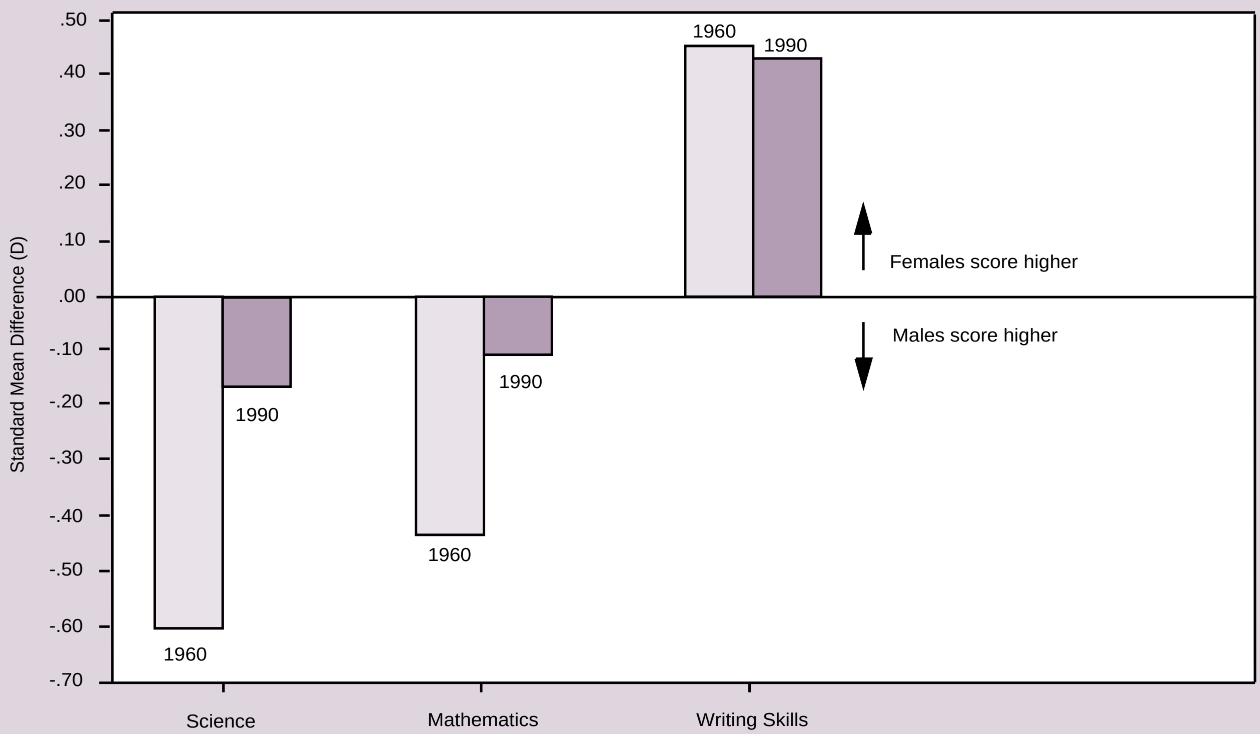
Figure 2-8.
**Gender difference in three subjects, 1960–1990**




SOURCES: Project TALENT and ETS Gender Study

NOTE: Cited in *The ETS Gender Study* by Nancy Cole (May 1997).

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lus grades when the SAT was used alone[12].... We found that...adding high school grades corrected the underprediction. In fact, using grades alone would have resulted in underprediction of calculus grades for males in those cases" (pp. 19–20). However, both grade point averages and test scores are the key factors in institutional selection, so there may be problems of severe selection bias associated with these findings.

- "We found that the differences cut both ways and that 12th grade girls have substantially closed the familiar mathematics and science gap over the past 30 years, but there continues to be a fairly large gap in writing skills that boys have not closed." (See figure 2-8.)

There is a gap between men and women in writing, but is it relevant for scientists and engineers? As National Education Goals for the year 2000, Goal 3, Objective 2 recommends that "the proportion of college graduates who demonstrate an advanced ability to think critically, communicate effectively, and solve problems will increase substantially" (National Education Goals Panel, 1997). "Good communication skills, both verbal and written, rank high among the top priorities of those in business and industry" (Barabas, 1990). Employers of engineering graduates rated speaking/writing as one of the most important areas of competence, and yet these same areas were identified as the most deficient in these graduates (Kimel and Monsees, 1979).

### College Credit From Advanced Placement

Half of the high schools in the United States offer Advanced Placement (AP) college-level classes, and the number of students taking AP tests for college credit is increasing each year, reaching over 500,000 students in 1996. Of these, 200,000 qualified for college credit by earning a certain score on AP exams taken in high school (College Board, 1996c).

[12] Bridgeman, B., and C. Wendler. 1991. Gender differences in predictors of college mathematics performance and in college mathematics course grades. *Journal of Educational Psychology*, 83, 275–284.

Wainer, H., and L.S. Steinberg. 1992. Sex differences in performance on the mathematics section of the Scholastic Aptitude Test: A bidirectional validity study. *Harvard Educational Review*, 62, 323–336.

Of the subjects offered for AP exams, 12 are science or mathematics subjects. Women constituted over half of the test takers in psychology and biology. These subjects were followed by calculus AB[13] (47 percent female) and chemistry (42 percent female). The science subject in which women were least likely to take an AP exam was computer science, where women accounted for only 20 percent of the computer science A and 12 percent of the computer science AB[14] test takers. (See appendix table 2-17.)

## Underrepresented Minorities

### *Introduction*

Students who decide to go to college usually take a college admissions test if they are planning to apply to a 4-year college or university, but may not take the test if they are planning only to apply to a 2-year college. Two-year colleges play a somewhat larger role in the higher education of minority students than they do of white students. (See text table 2-4.)

College admission test data for "1996 college bound students," then, may not be representative of all students who went on to college, especially for Hispanic and American Indian students.

For those who decide to take a college admission test, registration includes a student questionnaire. Both the ACT and the SAT student questionnaires ask for race/ethnicity.

[13] The College Board's Advanced Placement Program offers two levels of advanced placement examinations in calculus—calculus AB and calculus BC. Calculus BC covers more advanced topics than calculus AB.

[14] The College Board's Advanced Placement Program offers two levels of advanced placement examinations in computer science—computer science A and computer science AB. Computer science AB covers more advanced topics than computer science A.

Text table 2-4.
**Percentage of undergraduates enrolled in 2-year colleges, by race/ethnicity: 1995**

| Race/ethnicity | Percentage |
|---|---|
| White | 43 |
| Asian/Pacific Islander | 46 |
| Black | 47 |
| Hispanic | 60 |
| American Indian/Alaskan Native | 54 |

SOURCE: Barbett and Korb (1996, p. 15).

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Text table 2-5.
**Percentage of college admissions test takers in each racial/ethnic group taking the SAT or ACT: 1996**

| Racial/ethnic group | Percentage taking SAT | Percentage taking ACT |
|---|---|---|
| White | 51 | 49 |
| Asian/Pacific Islander | 76 | 24 |
| Black | 55 | 45 |
| Hispanic[1] | 64 | 36 |
| American Indian/ Alaskan Native | 44 | 56 |

[1] Does not include students in Puerto Rico.

SOURCE: College Board and American College Testing, unpublished tabulations, 1996.

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- On the form for the SAT, students are asked "How do you describe yourself?" and one of the categories offered is an "other" category. Eleven percent of 1996 SAT test takers chose "other" or did not respond to this question.
- On the form for the ACT, students are asked "Which best describes your racial/ethnic background?" and "other," "multiracial," and "prefer not to respond" categories are offered. Eleven percent of 1996 ACT test takers chose one of these three categories.

Therefore, the data provided on ACT and SAT by race/ethnicity groups cover 89 percent of both ACT and SAT test takers.

There are some differences in the proportions of each racial/ethnic group who take the SAT versus the ACT. (See text table 2-5.) Some of these differences reflect the distinct differences found by State (see sidebar on page 29). For example, American Indian/ Alaskan Natives are much more likely to take the ACT and Asian/Pacific Islanders are much more likely to take the SAT.

Note that the data presented in this section do not include students in Puerto Rico. The ACT is not given in Puerto Rico and although an SAT-equivalent test is given in Puerto Rico, those test scores are not included in the SAT data for Hispanics. Since Puerto Ricans ages 16 to 19 years living in Puerto Rico account for 14 percent of the Hispanic population in the United States (Puerto Ricans living on the continent account for another 10 percent of the Hispanic population) (U.S. Department of Commerce, 1993a, b), a significant part of the Hispanic population overall is not included in

## Percentage of High School Graduates[1] Taking the SAT or ACT by State: 1996

| States | Percentage taking SAT | Percentage taking ACT | States | Percentage taking SAT | Percentage taking ACT |
|---|---|---|---|---|---|
| National | 41 | 35 | Missouri | 9 | 63 |
| Alabama | 8 | 57 | Montana | 21 | 54 |
| Alaska | 47 | 35 | Nebraska | 9 | 72 |
| Arizona | 28 | 27 | Nevada | 31 | 39 |
| Arkansas | 6 | 64 | New Hampshire | 70 | 3 |
| California | 45 | 11 | New Jersey | 69 | 2 |
| Colorado | 30 | 60 | New Mexico | 12 | 59 |
| Connecticut | 79 | 2 | New York | 73 | 16 |
| Delaware | 66 | 4 | North Carolina | 59 | 11 |
| District of Columbia | 50 | 5 | North Dakota | 5 | 77 |
| Florida | 48 | 34 | Ohio | 24 | 58 |
| Georgia | 63 | 16 | Oklahoma | 8 | 63 |
| Hawaii | 54 | 15 | Oregon | 50 | 11 |
| Idaho | 15 | 59 | Pennsylvania | 71 | 6 |
| Illinois | 14 | 67 | Rhode Island | 69 | 1 |
| Indiana | 57 | 19 | South Carolina | 57 | 13 |
| Iowa | 5 | 64 | South Dakota | 5 | 65 |
| Kansas | 9 | 70 | Tennessee | 14 | 77 |
| Kentucky | 12 | 62 | Texas | 48 | 30 |
| Louisiana | 9 | 73 | Utah | 4 | 66 |
| Maine | 68 | 2 | Vermont | 70 | 3 |
| Maryland | 64 | 9 | Virginia | 68 | 5 |
| Massachusetts | 80 | 5 | Washington | 47 | 15 |
| Michigan | 11 | 64 | West Virginia | 17 | 54 |
| Minnesota | 9 | 59 | Wisconsin | 8 | 63 |
| Mississippi | 4 | 68 | Wyoming | 11 | 64 |

[1] Based on number of high school graduates in 1996 as projected by the Western Interstate Commission for Higher Education and number of students in the class of 1996 who took the SAT or ACT.

NOTES: Puerto Rico is not included. A very low percentage of students may have taken both tests.

SOURCE: College Board (1996c) and American College Testing (1996).

this section. The number of high school graduates in Puerto Rico is increasing (in 1996, a total of 36,600 students graduated from both public and private high schools in Puerto Rico), and many of these graduates consider going to college and taking the SAT. The SAT-equivalent test administered in Puerto Rico by the College Board is given in Spanish; for academic year 1995–1996, 32,490 persons took the test, of whom 58 percent were women. Only about one-fourth of persons who took the test had a parent who had a college degree (College Board, 1995), so most of these students were the first generation in their families to go to college.

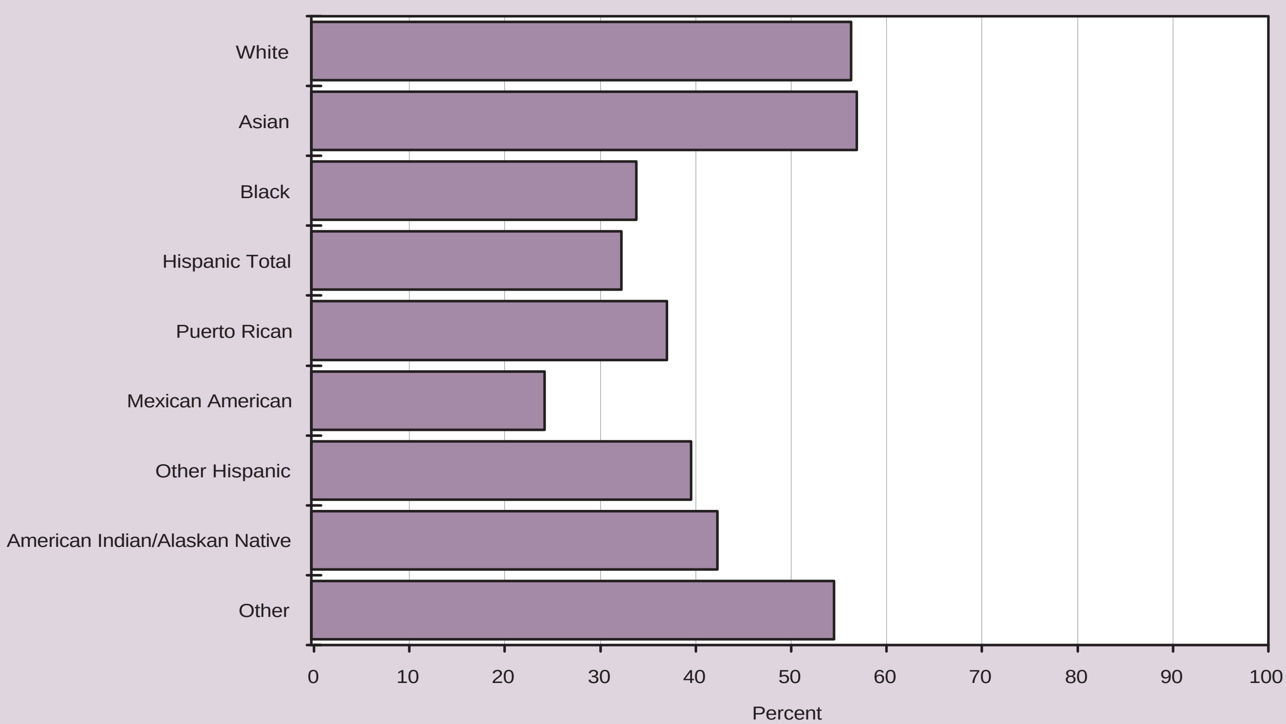
## Increased Participation in College Admissions Test Taking

One of the major pieces of information derived from data on the ACT and SAT is that the number of high school seniors from underrepresented minority groups taking college admissions tests has increased significantly in the 1990s. Although the number of white students taking the SAT declined slightly (–1 percent) between 1991 and 1996, the number of minority students taking the test has increased 13 percent (the largest percentage increases were among Mexican American and Latin American students). (See appendix table 2-18.) During this same period, the number of ACT test takers increased 11 percent for whites and 29 percent for minority students. (See appendix table 2-19.)

The College Board data indicate that a higher proportion of underrepresented minorities make the decision to take a college admission test late in high school. Students who have plans for college early in high school often begin by taking a commercial "diagnostic SAT" in 10th grade, the PSAT in 11th grade, sometimes an SAT preparation class, and then the SAT in 11th grade and/or 12th grade. Parents play a major role in educating their children to this schedule and process, particularly if the parents have gone to college themselves. But college experience of parents varies greatly by racial/ethnic group, with blacks, Hispanics, and American Indians having the lowest percentages of parents with college degrees. (See figure 2-9.) Among these underrepresented groups, the majority of high school seniors taking the SAT are trying to be the first generation of their family to go to college. (See appendix table 2-20.)

Although guidance counselors and teachers in the schools may help some "first-generation" students

Figure 2-9.
**Percent of SAT takers who have a parent with a college degree, by race/ethnicity: 1996**




SOURCE: College Board, unpublished tabulations, 1996.

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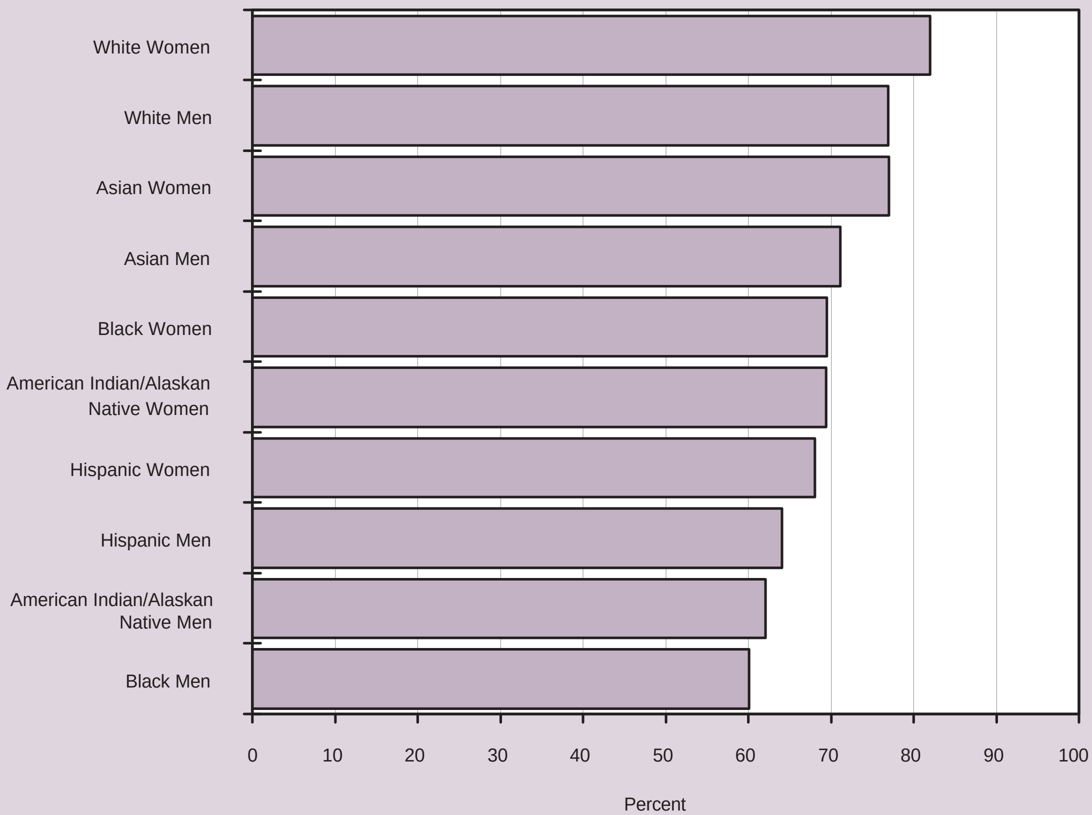
Figure 2-10.
**Percent of 1996 SAT takers who took the PSAT, by race/ethnicity and sex**




SOURCE: College Board, unpublished tabulations,1996.

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understand this process of planning for college, data on the percentage of SAT takers who had taken the PSAT earlier indicate that this process was not taking place for a higher percentage of students in these underrepresented groups. The students with the lowest percents who had taken the PSAT were Hispanic, American Indian, and black men; the next lowest percentages were among the women in these groups. (See figure 2-10.)

## Increased Preparation for College

The American College Testing service has been tracking the percentage of their test takers who have taken core courses in high school: 4 years of English and 3 years each of mathematics, science, and social studies. The number of students who have taken at least a core curriculum in high school has been increasing greatly, from 51 percent in 1991 to 61 percent in 1996. Among underrepresented minorities, the increases have been significant also: for blacks—an increase from 45 to 55 percent of test takers; for American Indians—an increase from 40 to 49 percent; and for Hispanics—an increase from 49 to 56 percent. The increase for Asians was 64 to 71 percent of test takers (American College Testing, 1996).

Data on test takers by race are also available by family income. Average ACT scores for each racial/ethnic group are higher for those with core curriculum preparation, as would be expected; average scores also increase with family income. (See appendix table 2-21.)

## College Credit From Advanced Placement

The number of high school students enrolling in AP courses and then taking AP tests for college credit has increased considerably in the last few years. Over half of the high schools in the United States offer AP college level classes; in 1996, over 500,000 students enrolled in AP classes. Of these, 40 percent qualified for college credit from their scores on AP exams taken in high school (College Board, 1996c).

## Studies on the Effects of California Proposition 209, *Hopwood* v. *Texas*, and the Use of Test Scores on Student Access at Selective Colleges and Universities

A new study (Nettles and Perna, 1997) by the Frederick T. Patterson Research Institute of The College Fund/UNCF addresses this issue. The authors, Michael Nettles and Laura Perna, discuss the challenge of admissions tests in the admissions process. "The way colleges and universities treat admissions test scores, such as the Scholastic Assessment Test (SAT), the American College Test (ACT) and the Advanced Placement (AP) examinations, in the admissions process plays a vital role in the number of African Americans and Hispanics who are admitted and who enroll. The variety and range of criteria including admissions tests and other characteristics of individuals (e.g., geographic origin, alumni relations, educational and career aspirations, etc.), as well as the weight assigned to each criterion, is important" (p. 19). To understand the role of affirmative action, The Patterson Research Institute plans to study further a sample of highly competitive universities to understand the possible impact of California Proposition 209 and *Hopwood* v. *Texas* on diversity.[15]

The Educational Testing Service is also completing a study called "Hopwood, Bakke, and Beyond in College Admissions" (Educational Testing Service, 1997). If college admissions are based more on test scores as a result of these, and since underrepresented minorities constitute only 4.1 percent of students who scored 1200 or higher on the SAT, it is important to know more about the students scoring between 1000 and 1200 on the SAT. This study examines the "educational striver" student pool.

Continuing earlier studies by Claude Steele at Stanford University (see National Science Foundation, 1994, 1996), a new study describes how negative stereotypes are achievement barriers and how they shape the intellectual identity of women and minorities. Steele's research shows that this "threat dramatically depresses the standardized test performance of women and African-Americans who are in the academic vanguard of their groups (offering a new interpretation of group differences in standardized test performance)." He offers strategies for policy and practice in schools that can reduce the threats to stereotyped groups (Steele, 1997, p. 613).

[15] California Proposition 209 is a California constitutional amendment that prohibits State and local agencies including public colleges and universities from using preferences based on race or gender. *Hopwood* v. *Texas* ruled that race may not be used as a factor in admissions, and the Texas Attorney General ruled that the ban must also include financial aid, recruiting, and undergraduate admissions.

Of the subjects offered for AP exams, 12 are in science or mathematics. The AP courses with the highest number of underrepresented minorities enrolled were calculus AB and biology. The proportion of underrepresented minorities among the AP candidates in these two subjects was 9 percent for both; for chemistry and physics B, the representation was 8 and 7 percent, respectively. (See appendix table 2-22.)

According to the American Association of Collegiate Registrars and Admissions Officers (AACRAO), admissions officers are impressed by Advanced Placement course taking—even if the test is not taken. This importance makes it necessary to understand some of the differential opportunities for minority students to take the AP classes. The Advanced Placement at the College Board indicated that the schools that don't offer AP classes fall into four categories:

- small religious schools,
- small rural schools,
- schools in Wyoming, the Dakotas, and a few other States, and
- large urban schools, particularly if they feed into academic magnet schools.

Although the first three groups may affect large numbers of American Indians, these and the last category may affect large numbers of black and Hispanic students. Wade Curry, head of the AP at the College Board, explained that "magnet high schools draw off the most academically inclined students and produce fairly large numbers of AP scholars. But the schools they draw from then tend not to offer the courses, leaving those students behind." He has found that "African American students who do well on the AP tests tend to be either in the urban magnets or in predominantly white, suburban school systems where there are between five and twenty African American students who take the courses" (Chenoweth, 1997, p. 22).

### Persons With Disabilities

Data on disability from the SAT and ACT are collected in two ways: from student questionnaires and from requests for special testing accommodations.

Text table 2-6.
**Average SAT verbal and mathematics scores by disability status: 1996**

| Indicated a disability | Verbal average | Mathematics average |
|---|---|---|
| Yes (N=42,789)[1]……….. | 472 | 468 |
| No (N=921,317)………… | 509 | 512 |

[1] Includes those indicating blindness (5,548), deafness (3,262), paraplegia (167), learning disability (19,399), other neurological/ orthopedic impairment (2,929), multiple disabilities (251), and "other" (11,233).

SOURCE: College Board, unpublished tabulations, 1996.

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## Student Questionnaires

When persons first register to take college placement exams, they are asked on the student questionnaires to (1) "Indicate any permanently disabling condition," with six response choices (SAT), or (2) "Please respond to this item only if you have a physical or diagnosed learning disability," with eight categories (ACT). The ACT states on the student questionnaire that the information is used by colleges only to provide financial aid and special services.

About 5 percent (over 40,000) of students taking the SAT in 1996 checked a category indicating a disability; the ACT also had 5 percent (almost 20,000) of students who indicated a disability category in 1996.

Text table 2-7.
**Average ACT scores by disability status: 1996**

| Indicated permanent: | Average ACT score |
|---|---|
| Blindness (N=4,503)…………………………. | 17.2 |
| Hearing impairment (N=10,039)……………. | 20.2 |
| Learning disability (N=7,904)………………. | 16.1 |
| Attention deficit disorder (N=10,483)………. | 19.3 |
| Other neurological disorder (N=1,347)…….. | 19.3 |
| Require wheelchair access (N=360)………. | 19.1 |
| Other orthopedic (N=1,634)………………… | 20.3 |
| Multiple disabilities (N=980)……………….. | 19.8 |
| Other (N=7,256)…………………………….. | 17.8 |
| Did not indicate disability…………………... | 21.0 |

SOURCE: ACT, unpublished tabulations, 1996.

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Among college-bound seniors in 1996 who indicated a disability and took the SAT, 51 percent were male and 49 percent female; underrepresented minorities accounted for 18 percent of those indicating a disability (compared with 21 percent for all college-bound seniors) (ACT and SAT, unpublished tabulations).

The average SAT scores in 1996 of those who indicated a disability were lower than those who did not. (See text table 2-6.)

Data from the ACT are reported according to the category of disability and show variability among the groups of students in terms of their average scores in 1996. (See text table 2-7.)

## Special Testing Format/Conditions

Among SAT test takers, almost 20,000 students took the test under nonstandard conditions. These test takers had average scores (463 verbal and 452 mathematics) that were below the average of all test takers who indicated on the student questionnaire that they had a permanent disability yet did not request special testing formats (472 verbal and 468 mathematics) (College Board, unpublished data).

The ACT also has data available on the almost 20,000 students who requested special testing formats. (See text table 2-8.) Many of these students

Text table 2-8.
**Number of students with disabilities taking the ACT test with special formats, by type of disability: 1996**

| Special tested students (ACT) | Number in 1996 |
|---|---|
| Total based on disability……………….. | 19,526 |
| Learning disabled…………………………. | 4,426 |
| Attention deficit disorder………………… | 4,358 |
| Dyslexic……………………………………. | 2,849 |
| Developmental mathematics disorder.... | 2,724 |
| Developmental writing disorder……….. | 2,394 |
| Visually impaired…………………………. | 870 |
| Physically impaired………………………. | 511 |
| Deaf………………………………………… | 499 |
| Psychological disability…………………. | 295 |
| Anxiety disorder………………………….. | 226 |
| Epilepsy…………………………………… | 132 |
| Tourette syndrome………………………. | 81 |
| Emotionally disabled…………………….. | 75 |
| Other (cerebral palsy, homebound, etc.). | 86 |

SOURCE: ACT, unpublished tabulations, 1996.

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## Equity, Fairness, and Educational Testing

Achievement test scores are only one of many factors used to predict success in higher education. Reliance on test scores in decisions about individual students or in policy decisions involving groups of students raises issues of equity and fairness in the educational system and in the distribution of "rewards" for achievement. The following quotation from a Congressional report indicates how issues of equity and fairness have been linked with tests and their results (U.S. Office of Technology Assessment, 1992).

Steven Jay Gould's ... treatise on the history of intelligence testing is dedicated to "...the memory of Grammy and Papa Joe, who came, struggled, and prospered, Mr. Goddard notwithstanding."[1] ... As Gould explains midway through the book, Goddard had been one of a handful of prominent American psychologists who used test data to advance racist, xenophobic, and eugenicist ideologies. Although Goddard himself later recanted,[2] ... the atmosphere of the 1920s and 1930s gave tests "...the rather happy property of being a conservative social innovation. They could be perceived as justifying the richness of the rich and the poverty of the poor; they legitimized the existing social order."[3]...

Testing policy arouses the passions of Americans concerned with equal opportunity and social mobility. As in the past, those passions run in both directions: everyone may agree that testing can be a wedge, but some see the wedge forcing open the gates of opportunity while others see it as the doorstop keeping the gates tightly shut.

Consider, for example, the following excerpts ... :

> ...minority youngsters who...are disproportionately among the poor, tend to be relegated to poor schools, or tracked out of academic courses, just as young women are not encouraged to take math and science. Therefore, the differences in the "group" scores [on the Scholastic Aptitude Test]...represent anything but "bias." Rather, the score is a faithful messenger of the unequal distribution in our country of educational resources and encouragement.[4]
>
> Test makers claim that the lower test scores of racial and ethnic minorities and of students from low-income families simply reflect the biases and inequities that exist in American schools and American society. Biases and inequities certainly exist—but standardized tests do not merely reflect their impact; they compound them.[5]

... Both sides appear to agree that tests can be used to identify inequalities in educational opportunies.[6] But the question becomes how to use that information. Advocates of testing as a "gatekeeper" argue that ability and achievement, rather than family background, class, or the specific advantages that might accrue to students in wealthy school districts, should govern the distribution of opportunities and rewards in society. Moreover, they add, this system of distribution creates incentives for school systems to provide their students with the best possible chances for success.

On the other hand, opponents contend that ability and achievement scores are highly correlated with socioeconomic background factors[7] and with the quality of schooling children receive;[8] under these circumstances, "...no assessment can be considered equitable for students if there has been differential opportunity to access the material upon which the assessment is based."[9]

This debate will not be resolved easily or quickly; nor will it become moot with the advent of alternative methods of assessment. On the contrary, it could very well become even more heated and complex.[10]

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1 Steven Jay Gould, *The Mismeasure of Man* (New York, NY: Norton, 1981), dedication, p. 7.

2 See, e.g., Carl Degler, *In Search of Human Nature* (London, England: Oxford University Press, 1991).

3 Sheldon White, "Social Implications of IQ," *The Myth of Measurability*, Paul Houts (ed.) (New York, NY: Hart Publishing Co., 1977), p. 38. See also Clarence Karier, "Testing for Order and Control in the Liberal Corporate State," *The IQ Controversy*, N. Block and G. Dworkin (eds.) (New York, NY: Random House, 1976), pp. 339–373. Karier's basic argument, as summarized by another historian of testing, was "...the tests...were biased in terms of social class, economic, cultural, and racial background. Their use in schools served to block opportunity for the lower classes and immigrants...[and fashion] a system of tracking in the schools that reinforced social inequality..." Paul Chapman, *Schools as Sorters* (New York, NY: New York University Press, 1988), p. 8. For opposing viewpoints see, e.g., Mark Snyderman and Stanley Rothman, *The IQ Controversy* (New Brunswick, NJ: Transaction Books, 1988); Arthur Jensen, *Bias in Mental Testing* (New York, NY: Free Press, 1980); or Richard Herstein, "IQ," *Atlantic Monthly*, vol. 228, September 1971, pp. 43–64.

4 Donald Stewart, president, College Entrance Examination Board, "Thinking the Unthinkable: Standardized Testing and the Future of American Education," speech before the Columbus Metropolitan Club, Columbus, OH, Feb. 22, 1989.

## Equity, Fairness, and Educational Testing *(continued)*

[5] Monty Neill and Noe Medina, "Standardized Testing: Harmful to Educational Health," *Phi Delta Kappan*, Vol. 70, No. 9, May 1989, p. 691.

[6] For discussion of test bias and the effects of testing on minority students, see e.g., Walter Haney, Boston College, "Testing and Minorities," draft monograph, January 1991, p. 24.

[7] See, e.g., Christopher Jencks et al. *Inequality* (New York, NY: Basic Books, 1972).

[8] See, e.g., Ronald Ferguson, "Paying for Public Education: New Evidence on How and Why Money Matters," *Harvard Journal on Legislation*, Vol. 28, No. 2, Summer 1991, pp. 465–498.

[9] Shirley Malcom, "Equity and Excellence Through Authentic Science Assessment," *Science Assessment in the Service of Reform*, Gerald Kulm and Shirley Malcom (eds.) (Washington, DC: American Association for the Advancement of Science, 1991), p. 316. It is interesting to note that standardized test scores, viewed by some critics as blocking entry to education and work opportunities, have been used to justify major public programs to help minority and disadvantaged children: "...the preeminent example…was in the 1960s, when lower performance of minority and inner city children was used to bolster arguments for the war on poverty and to help propel passage of the landmark Elementary and Secondary Education Act of 1965..." (Haney, op. cit., footnote 7, p. 22.)

[10] Some minority educators, for example, fear that new assessment methods will stifle opportunities for minority students who have recently begun to do better on conventional tests. There is also uncertainty over whether or not tests should be used for placing children in remedial programs. Parents in California sued recently, not because their children were being tested but, on the contrary, because the State had followed the precedent set in the landmark *Hobson* v. *Hansen* case, and banned testing as a basis for diagnosing learning difficulties and placing children in remedial tracks. For further discussion of this and other legal issues, see ch. 2 [of source report].

do not fill out student questionnaires and, therefore, may not be included in the data presented above. Data from ACT on special testing formats are not nationally representative of any of the disability categories and do not include all students with disabilities (many of whom took the regular administration of the test). Still, it is interesting to note the variety of conditions of students who were taking the college placement tests under special testing administration (ACT, 1996, unpublished tabulations).

Students who take the ACT under special administration to accommodate a disability are often flagged as such when their test scores are provided to college admissions offices. The College Board funded a study on how the admissions process may be affected by these flags, as well as the validity of admissions tests scores for disabled applicants. The main finding of that study was that students with disabilities were admitted on much the same basis as the other applicants, though in some instances particular groups of applicants were somewhat less likely to be admitted than would be expected (learning disabled) or somewhat more likely to be admitted (for example, hearing impaired) to special programs. The report also states that "Admissions decisions predicted on the basis of either SAT or HSG (high school grades) correlated slightly less with actual decisions in the case of handicapped applicants than others. This result suggests that factors other than SAT and HSG play a slightly larger role in the case of handicapped applicants, though not necessarily to their advantage" (Willingham, 1988, p. 81).

Advanced Placement Exams do not collect data from the students on any possible disability. If requested and approved, however, AP exams are offered at the high school site in a variety of testing alternative procedures, which include special arrangements, extended time, use of a reader or sign language interpreter, or special test editions (for example, Braille, cassette, photo-enlarged). Students must have official certification of their disability on file at the school to verify the need for special testing arrangements. The number of AP science exams taken in May 1997 under special testing arrangements were

| | |
|---|---|
| Biology | 267 |
| Chemistry | 112 |
| Physics B | 55 |
| Physics A | 50 |

Note that these numbers would not include the disabled students who took AP exams under regular testing conditions.

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